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EMERGENCY HANDLING OF COMPRESSED AIR CASUALTIES

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ABSTRACT

Work in compressed air is associated with a number of hazards, the most serious of which are the pressure-related injuries (burst lung and decompression sickness). Modern construction methods and newer decompression tables have considerably reduced overall risks. The newest treatment methods have similarly reduced morbidity and fatality risks when an accident occurs. This paper outlines the basics of emergency handling of casualties and the definitive treatment of pressure related accidents.

INTRODUCTION

Hazards of the compressed air environment are numerous and all workers must be educated to avoid them. Good safety practices, adequate planning and familiarity with emergency procedures should prevent most accidents. However, accidents can occur despite stringent safety precautions, and when a worker is injured, proper emergency handling will often prevent permanent injury or death.

Hazards that are most serious and require rapid emergency handling can be listed as follows in order of seriousness:

a. pulmonary overpressure syndrome (or burst lung) which can lead to air embolism, pneumothorax and/or mediastinal and subcutaneous emphysema;

b. decompression sickness;

c. incapacitation due to physical injury or pressure related injury; and

d. incapacitation due to natural diseases.

Emergency handling of a casualty has been divided into four phases by Dr. Eric Kindwall of St. Luke's Hospital, Milwaukee, Wisconsin, U.S.A. These phases are:

a. immediate emergency care;
b. diagnosis;
c. transportation; and
d. definitive treatment.

Immediate Emergency Care

Aside from natural diseases, the worker who becomes incapacitated after surfacing is most likely suffering from burst lung or from decompression sickness.

Immediately have the victim lie down. If he has lung symptoms or nervous system symptoms, keep him lying down on his right side with his head lower than his feet. Loosen tight clothing around the neck and chest and keep him warm with covers or blankets.

If respiration is absent, apply mouth-to-mouth resuscitation. Check for heart action (over the heart itself or feel carotid or femoral pulse) and adequate pulse and apply external cardiac massage if indicated.

CONTINUE THESE MEASURES UNTIL THE PATIENT REVIVES
OR IS PROUNOUNCED DEAD BY A PHYSICIAN.

In moving and transporting the patient, keep him lying in the head down position at all times and do not interrupt resuscitation.

The worker who becomes incapacitated while under pressure may be suffering from burst lung, decompression sickness, physical injury (including over-exertion or exhaustion) or breathing toxic gas.

Immediately follow the steps outlined above.

All the causes of incapacitation require that the victim be placed lying down with head lower than feet, given adequate ventilation and ensured of adequate circulation.

Diagnosis

Diagnosis is important, but if a diagnosis cannot be rapidly made on the basis of the history of the pressure exposure and the status of the victim, time should not be wasted in getting the victim treated. Whether the diagnosis can be made or not, as much information as possible about the status of the victim (pulse, respiration, blood pressure, colour, consciousness, symptoms of pain, respiratory distress, etc.) and the pre-accident situation should be gathered, condensed and passed on to the treatment facility. This information should be passed verbally in advance of the victim and also via detailed notes accompanying the victim.

The most immediately dangerous situation likely to be encountered is the burst lung syndrome. The victim usually experiences symptoms within minutes of surfacing, related to the lung or the nervous systems. There may be frothy, bloody sputum, cyanosis and dyspnoea, unconsciousness, convulsions, paralysis or any 'stroke-like' syndrome. There is almost always chest pain. A delay of longer than 20 minutes before symptoms develop will rarely occur. Signs that may be present are:

a. mottling of the tongue;

b. unequal pupils;

c. subcutaneous emphysema over the neck and upper chest (feels crunchy or crackly on pressing it with the hand);

d. swelling of the neck;

e. voice changes; and

f. paresthesia, anaesthesia or paralysis following definite nerve distributions.

<u>If pneumothorax alone is present, there may be:</u>

a. tachypnoea (rapid breathing);
b. general cyanosis;
c. uneven chest expansion;
d. tympany (drum-like sounds when tapped) of the affected side;
e. absence of breath sounds on the affected side;
f. acute respiratory distress;
g. shift of the trachea to the remaining good side; and
h. subcutaneous emphysema in the chest and neck regions.

The diagnosis of pulmonary overpressure syndrome resulting in any central nervous system symptoms or signs obliges the examiner to transport the patient to a treatment facility for recompression as quickly as possible.

Decompression sickness is the most common serious pressure-related injury. Symptoms and signs will usually appear within two hours but may be delayed for as long as 24 hours. For this reason a worker is "at risk" for a period of 24 hours and should report any unusual symptoms or signs suggestive of decompression sickness to a doctor trained in diving medicine or a treatment centre.

The most common manifestation of decompression sickness is pain, usually in the area of a joint. The pain may be a deep dull ache or an intolerable throbbing pain that causes the affected area to be immobilized and weak. There may also be patchy cyanosis, erythema or oedema of the skin (blueness, redness or swelling respectively) with moderate to severe itching in these and adjacent areas.

Up to 25% of all cases of decompression sickness may involve the nervous system with severe and/or dangerous effects which require urgent treatment. These are:

a. regional numbness, loss of sensation, or paralysis (usually with a definite nerve distribution);

b. vertigo (staggers);

c. visual disturbances (tunnel vision, flashing lights, partial or total blindness);

d. nausea and malaise;

e. apprehension and confusion;

f. aphasia (loss of speech); and

g. unconsciousness or coma.

Some 2% of cases may have involvement of the cardio-respiratory system (chokes) such as:

a. dry, harsh cough, possibly paroxysmal;
b. wheezing;
c. dyspnoea;
d. chest pain on inspiration; and
e. general cyanosis.

Transportation

Because rapid transportation of a casualty may mean the difference between total recovery and permanent injury or death, planning should take into account what modes of transportation are available for reaching a treatment centre and what aid can be called on for transport, e.g. ambulance services, police, military, etc.

The most rapid means of transportation is obviously by air, but it is fraught with problems that are often overlooked. It usually takes time to organize air transport and often requires some mode of secondary transport from airport to treatment centre. Road transport may be shorter overall than air transport.

Aid for transportation, particularly air transportation can be obtained by contacting the local military Rescue Co-ordination Centre which provides emergency rescue and transport services throughout Canada. If air transport is used, it must be noted that flying at moderate or high altitude even in pressurized aircraft can cause worsening of burst-lung syndrome or decompression sickness due to the added pressure drop caused by going to altitude. Air transport should therefore

be at low level if the aircraft utilized is unpressurized, e.g. a helicopter. An aircraft which can be pressurized such as C130 Hercules should be used if possible.

During transportation, the victim should be kept recumbent in the head-down position and be kept warm. He should be given 100% oxygen by double seal oronasal mask if available. He should be given fluids to drink or intravenous solutions to keep him well hydrated (dehydration usually occurs in pressure related accidents and complicates the disease). He must also be monitored for urinary output since in air embolism or decompression sickness bladder function can be lost and may be the first sign of CNS complications.

If the victim is seen by a physician in the staging area or is taken to a hospital facility en route due to severity of conditions, definitive treatment with drugs may be initiated (see below).

Definitive Treatment

The only adequate form of treatment for cerebral air embolism and diving related decompression sickness is to recompress the patient in a recompression chamber.(*) This results in reduction in size of the gas bubbles which initiate the pathology in both disease states and allows the gradual elimination of the accumulated gas. It also allows the administration of hyperbaric oxygen which alleviates tissue hypoxia and speeds inert gas elimination.

Recompression in a dry chamber allows careful monitoring and implementation of medical treatment regimens such as artificial ventilation, intravenous fluid therapy, drug therapy, and chest tube insertion.

Burst lung syndrome resulting in cerebral or spinal air embolism is preferably treated using the oxygen recompression treatment table designated as 6A. Type I (mild decompression sickness) is generally treated using oxygen recompression treatment Table 5, and Type II (severe decompression sickness) is treated with Table 6 or 6A. Alternatives to these treatment tables are occasionally used depending on the severity and progress of the case.

Other adjuncts to treatment that may be used in the chamber and in severe cases may be used before or during transport include intravenous fluids, assisted ventilation, antibiotics, steroids, urinary cathe-

(*) NOTE: Aviators who develop pain only bends (Type I DCS) at altitude may be treated with 1-2 hrs of oxygen at 1ATA via double seal oronasal mask (with or without ancillary measures) if the pain is no longer present upon return to ground level. (See Chapter 5 of Ref 5).

terization, etc. Maintaining adequate intravascular volume with Ringer's Lactate or oth crystalloids is very important if gas elimination is to be maximized. (1 litre in first hour and then maintain urinary output of 1-2 ml/Kg/hr.). 5% Dextrose in water is not recommended since it tends to aggravate fluid loss from the vascular compartment.

Specific drug therapy that aids in counteracting some of the effects secondary to decompression sickness includes the infusion of Dextran 40 (Rheomacrodex) 10% solution given at a rate of 10 ml/kg/24 hours. In very severe cases, half the total allowable dose may be given rapidly over a half-hour and the rest slowly over the remaining 12-24 hours. Heparin, an anticoagulant, may be given but should be used only in the hospital setting where careful monitoring of the effects of the drug can be undertaken. Steroids should only be given in cases of severe shock or trauma or central nervous system oedema; e.g. dexamethasone 10-40 mg IV followed by 4-8 mg IM q6h for up to 3 days. Tapering is not necessary with this dose range. Glycerol at 1gm/Kg given orally in a 50% solution of flavoured water (e.g. lemon juice) is also helpful in reducing CNS edema. (Note: 1 gm = 0.8 cc glycerol and nasogastinc tube may be used if solution is not tolerated orally).

Burst lung syndrome cases should have a chest x-ray taken and if this shows a diffuse non-specific increased density over the lung fields, it is pathognomonic for burst lung. This clears in 24 to 72 hours and is not related to any symptoms or signs. Burst lung syndrome in the absence of arterial gas embolism does not require recompression therapy. Treatment of mediastinal and subcutaneous emphysema, pneumothorax, and pneumopericardium in the absence of CNS symptoms requires only observation and bed rest for 24 hrs. 100% oxygen may be used and occasionally a chest tube is required for treatment of pneumothorax.

The longer the delay in initiating recompression treatment in cases of cerebral air embolism or decompression sickness, the greater the probability that the patient will suffer from residual effects even after long or repeated treatments. If the delay between the onset of symptoms and signs has been greater than eight hours, the likelihood of residual symptoms and signs remaining is of the order of 10%. Early treatment is therefore very important and in the rare case in which the disease syndrome has been misdiagnosed and is not burst lung or decompression sickness, early and proper recompression treatment will have done no harm to the patient.

Oxygen Recompression Treatment Tables

General considerations:

a. follow the treatment tables accurately;

b. permit no shortening or alteration of the tables except on the order of a Diving Medical Officer or in an extreme emergency. Intravenous diazepam is usally effective in controlling the severe vertigo of labyrinthine DCS as well as unmanageable vomitting or agitation. This medication is also useful in treating convulsions lasting more than 1-2 minutes;

c. the normal rate of descent in the chamber is 25'/min (7.5m/min);

d. if serious symptoms and signs are present rapid descent is desirable;

e. if pain increases on descent, stop the descent and resume descent at a rate tolerable to the patient;

f. go to the full pressure indicated by the table used; and

g. do not go beyond 165' (50 metres) except on the decision of a Diving Medical Officer.

Examination of the Patient:

a. except for cerebral air embolism or severe DCS the patient should be examined by the Diving Medical Officer prior to being recompressed in order to facilitate an exact diagnosis;

b. examination in the chamber is possible, but, cramped quarters, noise, etc., make conditions less than ideal;

c. in any severe case do not delay recompression for examination purposes or for purposes of determining which treatment table to use;

d. on reaching the treatment pressure, examine the patient as completely as possible to detect evidence of incomplete relief or symptoms and signs overlooked. If possible, have the patient stand and walk the length of the chamber;

e. re-examine the patient completely before leaving the initial treatment pressure;

f. ask the patient how he feels before and after coming to each stop and periodically during the long stops;

g. do not let the patient sleep during the ascent phases of the treatment or for more than one half-hour at a time during any of the stops;

h. re-examine the patient before leaving the last stop;

j. during the treatment, make sure that the patient can obtain all the things that he needs in the way of food, drink, reading or writing material;

k. examine the patient carefully on completion of the treatment and with severe cases re-examine one hour after completion of the treatment;

m. in case of recurrence, keep the patient in close proximity to the chamber for 1-3 hours after treatment and within 30 minutes driving distance for 12 hours;

n. do not allow another pressure exposure for at least 7 days after Type I decompression sickness and 4 weeks for Type II DCS (as per CFP 380). Those times can be modified on the advice of a Diving Medical Officer but a minimum is 48 hours.

Tenders:

a. a qualified tender must be in the chamber with the patient at all times unless physically impossible (e.g. one-man chamber);

b. the tender must be alert for any changes in the condition of the patient especially during oxygen breathing;

c. when Tables 5, 6 or 6A are used, the tender normally breathes air when the patient is on oxygen. He may breathe oxyhelium at pressures greater than 60 fsw (18 metres) if the patient is on oxyhelium. Some hyperbaric medicine experts recommend 50/50 nitrox or heliox at the 165' stop of Table 6A to maximize the effect of the O_2 gradient but this can only be used on the recommendation of a Diving Medical Officer and compression is to be on air;

d. the tender will remain with the patient throughout the whole treatment schedule. If an urgent requirement should arise to

have the tender come out of the chamber, then he must be decompressed according to an appropriate decompression schedule;

e. anyone entering or leaving the chamber during the progress of the treatment (such as a medical officer) must be monitored and decompressed appropriately if required; and

f. personnel outside the chamber must specify and control the decompression of anyone leaving the chamber and must review all decisions concerning the treatment or the decompression schedule made by personnel inside the chamber.

OXYGEN RECOMPRESSION TREATMENT - TABLE 5 *

DEPTH FSW	DEPTH MSW	TIME (MINUTES)	BREATHING MEDIA	TOTAL ELAPSED TIME
60	18	20	Oxygen	20
60	18	5	Air	25
60	18	20	Oxygen	45
60	18	5	Air	50
60 to 30	18 to 9	30	Oxygen	1:20
30	9	5	Air	1:25
30	9	20	Oxygen	1:45
30 to 0	9 to 0	30	Oxygen	2:15

TOTAL ELAPSED TIME DOES NOT INCLUDE
TIME REQUIRED TO PRESSURIZE TO 60' (18M)

USE : Treatment of Type I decompression sickness when oxygen can be used and when symptoms and signs are relieved within 10 minutes at 60' (18m). The patient breathes oxygen from the surface.

DESCENT RATE: 25'/minute (7.6m/minute).

ASCENT RATE : 1'/minute (.3m/minute). Do not compensate for slower ascent rates. Compensate for faster ascent by halting the ascent for the appropriate time period.

TIME : Time at 60' begins upon arrival at the depth.

If oxygen breathing must be interrupted due to toxic reactions, discontinue the oxygen for 15 minutes after the reaction has completely subsided and then resume the schedule at that point of interruption. If the interruption occurred at 60' switch to TABLE 6 upon arrival at 30'.

TENDER : The tender breathes air throughout the treatment and must stay for the duration of the treatment. (See note on Tenders).

* NOTE: The format of this table is different from the standard USN Table 5 in that there is a 5 min air period before travelling from 60 to 30 feet and no 5 min air period before travelling from 30' to the surface. Overall total elapsed time remains the same.

OXYGEN RECOMPRESSION TREATMENT - TABLE 6 *

DEPTH FSW	DEPTH MSW	TIME (MINUTES)	BREATHING MEDIA	TOTAL ELAPSED TIME
60	18	20	Oxygen	20
60	18	5	Air	25
60	18	20	Oxygen	45
60	18	5	Air	50
60	18	20	Oxygen	1:10
60	18	5	Air	1:15
60 to 30	18 to 9	30	Oxygen	1:45
30	9	5	Air	1:50
30	9	20	Oxygen	2:10
30	9	5	Air	2:15
30	9	20	Oxygen	2:35
30	9	5	Air	2:40
30	9	20	Oxygen	3:00
30	9	5	Air	3:05
30	9	20	Oxygen	3:25
30	9	5	Air	3:30
30	9	20	Oxygen	3:50
30	9	5	Air	3:55
30	9	20	Oxygen	4:15
30 to 0	9 to 0	30	Oxygen	4:45

TOTAL ELAPSED TIME DOES NOT INCLUDE
TIME REQUIRED TO PRESSURIZE TO 60' (18M)

USE : Treatment of Type I decompression sickness when oxygen can be used and symptoms and signs are not relieved within 10 minutes at 60' (18m) and the treatment of Type II decompression sickness. The patient breathes oxygen from the surface.

TENDER : 25'/minute (7.6m/minute).

ASCENT RATE : 1'/minute (.3m/minute). Do not compensate for slower ascent rates. Compensate for faster ascent rates by halting the ascent for the appropriate time period.

TIME : Time at 60' begins upon arrival at the depth.

NOTE: The format of this table is different from the standard USN Table 6 in that the O_2/Air periods at 30' are 20/5 vice 60/15. This format is to be adopted in the new CFP 380 for CF use but at present this can only be done on the recommendation of a Diving Medical Officer.

If oxygen breathing must be interrupted due to toxic reactions, discontinue the oxygen for 15 minutes after the reaction has completely subsided and then resume the schedule at the point of interruption.

TENDER : The tender breathes air throughout the treatment and must remain for the duration of the treatment. (See note on Tenders).

EXTENSION : Table 6 may be extended by 25 minutes (20 minutes O_2 - 5 minutes air) at 60'; by 75 minutes (20 minutes O_2 - 5 minutes air X 3) at 30', or by a combination of both. Use these extensions in serious cases or in cases where significant relief is not obtained on completion of the stop at 60'. Table 6A may be used in place of the extensions or with them in serious cases. (For more detailed selection criteria for the Tables, see above).

OXYGEN RECOMPRESSION TREATMENT - TABLE 6A (*NOTE 1)

DEPTH (BARS)	DEPTH (FSW)	TIME (MINUTES)	BREATHING MEDIA	TOTAL ELAPSED TIME
50	165	30	Air * Note 2	30
5.0 to 1.8	165 to 60	4	Air * Note 2	34
1.8	60	20	Oxygen	54
1.8	60	5	Air	59
1.8	60	20	Oxygen	1:19
1.8	60	5	Air	1:24
1.8	60	20	Oxygen	1:44
1.8	60	5	Air	1:49
1.8 to 0.9	60 to 30	30	Oxygen	2:19
0.9	30	5	Air	2:24
0.9	30	20	Oxygen	2:44
0.9	30	5	Air	2:49
0.9	30	20	Oxygen	3:09
0.9	30	5	Air	3:14
0.9	30	20	Oxygen	3:34
0.9	30	5	Air	3:39
0.9	30	20	Oxygen	3:59
0.9	30	5	Air	4:04
0.9	30	20	Oxygen	4:24
0.9	30	5	Air	4:29
0.9	30	20	Oxygen	4:49
0.9 to 0	30 to 0	30	Oxygen	5:19

TOTAL ELAPSED TIME INCLUDES THE TIME REQUIRED TO PRESSURIZE FROM SURFACE TO 165' (50MSW)

USE : The treatment of severe Type II decompression sickness and Arterial Gas Embolism when oxygen can be used and symptoms and signs of a moderate to major nature are relieved within 30 minutes at 165' (50m).

* NOTE 1: The format of this table is different from the standard USN Table 6A in that the O_2/Air periods at 30' are 20/5 vice 60/15. This format is being adopted in the new CFP 380 for CF use but at present this can only be done on the recommendation of a Diving Medical Officer.

* NOTE 2: Though air is shown as the breathing medium for the portion of the treatment schedule at depths greater than 60', many hyperbaric experts consider that 50/50 oxyhelium or N_2O_2 mixture is preferred if available. Again, this may only be done on the recommendation of a Diving Medical Officer and compression is to be on air.

DESCENT RATE: As fast as possible.

ASCENT RATE : From 165' to 60' at a rate of 26'/minute. From 60' to surface at a rate of 1'/minute. Do not compensate for slower ascent rates. Compensate for faster ascent rates by halting the ascent for the appropriate time period.

If oxygen breathing must be interrupted due to toxic reaction, discontinue the oxygen for 15 minutes after the reaction has entirely subsided and then resume the schedule at the point of interruption.

TENDER : The tender breathes air throughout the schedule unless O_2He or N_2O_2 is being used at which time the tender must also breath that mixture at depths greather than 60'. The tender must stay for the duration of the treatment. (See Note on Tenders).

EXTENSION : Table 6A may be extended by 25 minutes (20 minutes oxygen, 5 minutes air) at 60' and by 75 minutes (20 minutes oxygen, 5 minutes air X 3) at 30' or by the combination of both.

LACK OF RELIEF AT 165' (5 BARS) If there is partial relief or no improvement after the 30 minutes at 165' consider Air Saturation at 60 fsw for 12-18 hours (as advocated by Cdr E.D. Thalmann of NEDU, Panama City, Florida, AV 436-4355). Decompression schedule is 3 fsw/hr from 60 to 30 fsw, 2 fsw/hr from 30 to 10 fsw and 1 fsw/hr from 10 fsw to the surface. Tenders need not breathe O_2 during decompression. O_2 is administered to patient in 25 min O_2/5min air periods: 8-O_2 treatment periods are followed by 4 hr air breaks to a maximum of 24-32 Oxygen Treatment periods. Chamber ppO_2 must be kept above 18%, CO_2 below 15 Hg and temperature below 85°F. Extended Air Treatment @ 60 fsw is considered a heroic measure and should only be used in severe cases. Another alternative to Table 6A is the British method. (See Pg 15).

ALTERNATE TO TABLE 6A (BRITISH METHOD)

For the treatment of Decompression Sickness and Arterial Gas Embolism not relieved at 5.0 bars:

a. recompress the patient to pressure of relief on oxyhelium (20/80) mixture;

b. remain at pressure of relief for 30 minutes after relief has been obtained; and

c. decompress in stages as defined by the formula with each stage consisting of a period of continuous decompression (ascent) at a constant rate lasting five hours.

FORMULA

$$\frac{\text{INITIAL PRESSURE} + 1 \text{ Bar}}{1.3} - 1 \text{ bar} = \text{FINAL PRESSURE}$$

$$\frac{\text{INITIAL PRESSURE} + 14.7 \text{ psig}}{1.3} - 14.7 \text{ psig} = \text{FINAL PRESSURE}$$

INITIAL PRESSURE : Pressure at the beginning of the decompression stage. (This will equal the Pressure of Relief for the first STAGE and for subsequent STAGES will equal the FINAL PRESSURE of the preceding STAGE).

FINAL PRESSURE : Pressure at the end of a decompression STAGE.

d. at pressures less than 1.8 bars (60 fsw) put the patient on oxygen for periods of 25 minutes, interrupted by 5 minutes breathing oxyhelium or air; and

e. the tender will breathe oxyhelium at pressures greater than 1.8 bars and either air or oxyhelium at pressures less than 1.8 bars.

Recurrence of Symptoms and Signs

a. If there is recurrence during treatment, recompress to depth of relief but never less than 30 fsw (9m) or deeper than 165' (50m) except on the advice of a qualified Diving Medical Officer;

b. it has been shown that depth of relief for decompression sickness is frequently 1.5 times the depth of occurence of symptoms and signs (measured in absolute terms) and rarely higher, e.g. if the recurrence is at 20m absolute, the depth of relief will be 30m absolute;

c. if the recurrence involves serious symptoms and signs not previously present, recompress the patient to 165' and treat according to Table 6A or its alternative;

d. if there is recurrence following treatment, recompress the patient on Table 6 or Table 6A depending on the seriousness of the recurrence. If the recurrence is less severe than the original use Table 6. If the recurrence is equal to or greater than the original incident use Table 6A;

e. always re-examine the patient carefully at start of treatment and during treatment as outlined for initial treatments; and

f. do not omit the use of special ancillary treatment modes for decompression sickness in serious recurrent cases and consider carefully the use of the alternatives to Table 6A (see pages 5 and 6).

The Most Frequent Errors Related to Treatment

a. failure of the worker to report symptoms early;
b. failure to treat doubtful cases;
c. failure to treat promptly;
d. failure to treat adequately;
e. failure to recognize serious symptoms; and
f. failure to keep the patient near the chamber after treatment.

Notes on Artificial Respiration

1. Start artificial respiration immediately whenever a person is not breathing due to any cause:

a. never wait for a mechanical resuscitator;

b. interrupt only to stop serious bleeding (if possible have another person tend to such measures while you start artificial respiration; and

c. send another person for a medical officer or other competent aid.

2. Before starting, remove victim from cause of his trouble but do not waste time moving him any further than necessary.

3. Get on with artificial respiration @ 12-15/min. Leave details to others or try to get them done quickly between cycles:

a. Recheck Position of Victim:

(1) in position for mouth-to-mouth resuscitation;
(2) head slightly lower than feet if possible; and
(3) chin pulled upward.

b. Recheck Airway:

(1) remove froth, debris or other material;

(2) see that tongue stays forward; have someone hold it if it draws back; use an airway if possible; and

(3) if artificial respiration does not move any air, there is an obstruction. Strangulation must be overcome.

c. loosen any tight clothing - collar, belt, etc.;

d. keep victim warm; and

e. check pulse. If feeble, maintain victim lying in head down position. If absent, consider external cardiac compression.

4. Continue artificial respiration without interruption. (Minimum time is 4 hours unless victim revives or is pronounced dead by medical officer):

a. do not apply too much chest pressure. (A strong operator can crack ribs of a small victim);

b. if you become tired, let another operator take over. Do not break rhythm during shift;

c. watch carefully for signs of return of natural breathing movements. If they appear, time your movements to assist them;

d. shift to a mechanical resuscitator if one is available, ready and operating properly; and

e. if victim starts breathing himself; watch him carefully. Resume artificial respiration if he stops or if movements become too feeble.

5. If victim revives, continue care by:

a. keep him lying down;
b. remove wet clothes, keep warm;
c. give nothing by mouth until fully conscious;
d. attend to any injuries;
e. be sure patient is seen promptly by medical officer; and
f. do not handle roughly if moving patient.

Use of Oxygen

Use oxygen wherever permitted by the treatment tables unless the patient is known to tolerate oxygen poorly.

If a medical officer trained in hyperbaric medicine is available, he may recommend the use of oxygen even for patients who are known to tolerate oxygen poorly.

Take all precautions against fire.

Tend carefully, being alert for such symptoms of oxygen poisoning such as:

a. twitching of the face and lips;

b. nausea;

c. dizziness and vertigo;

d. vomiting;

e. anxiety;

f. convulsions;

g. confusion;

h. restlessness and irritability;

j. malaise or excessive tiredness;

k. changes in vision - as blurring or narrowing of the visual fields;

m. incoordination;

n. tremors of the arms and legs;

p. numbness or tingling of the fingers or toes;

q. fainting; and

r. spasmodic breathing.

Know what to do in the event of convulsion:

a. halt ascent;

b. remove mask at once;

c. protect the convulsing patient from injury but do not restrain or forcefully oppose the convulsive movements;

d. maintain pressure;

e. if the patient is not convulsing, have him hyperventilate with chamber air for a few breaths; and

f. notify Diving Medical Technician and/or Diving Medical Officer.

ACKNOWLEDGEMENT

The authors wish to acknowledge the work of Dr G.H. Koch whose technical report 76-X-39 formed the basis for this revised manual.

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